Acronym: Visual Performance

Title: Human Factors Assessment of Vibration Effects on Visual Performance During Launch

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Increment(s) Assigned: 18, 19, 20

Mission(s): STS-119/15A; STS-127/2J/A; STS-128/17A

Brief Research Summary (PAO): The Human Factors Assessment of Vibration Effects on Visual Performance During Launch (Visual Performance) investigation will determine visual performance limits during operational vibration and g-loads on the Space Shuttle, specifically through the determination of minimum readable font size during ascent using planned Orion display formats.

Research Summary:

- The aim of the Human Factors Assessment of Vibration Effects on Visual Performance during Launch (Visual Performance) investigation is to provide supplementary data to that collected by the Thrust Oscillation Seat Detailed Technical Objective (DTO) 695 (Crew Seat DTO) which will measure seat acceleration and vibration from one flight deck and two middeck seats during ascent. While the Crew Seat DTO data alone are important in terms of providing a measure of vibration and g-loading, human performance data are required to fully interpret the operational consequences of the vibration values collected during Space Shuttle ascent.

- During launch, crewmembers will be requested to view placards with varying font sizes and indicate the minimum readable size.

- In combination with the Crew Seat DTO, the Visual Performance investigation will:

- Provide flight-validated evidence that will be used to establish vibration limits for visual performance during combined vibration and linear g-loading.
- Provide flight data as inputs to ongoing ground-based simulations, which will further validate crew visual performance under vibration loading in a controlled environment.
- Provide vibration and performance metrics to help validate procedures for ground tests and analyses of seats, suits, displays and controls, and human-in-the-loop performance.

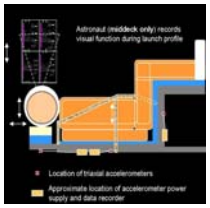
Detailed Research Description: The aim of the Human Factors Assessment of Vibration Effects on Visual Performance During Launch (Visual Performance) investigation will provide supplementary data to those collected by the Crew Seat DTO which is sponsored by the Orbiter Project Office. The Crew Seat DTO has been manifested on STS-119, STS-127, and STS-128. During ascent, this DTO will measure the linear and vibrational acceleration of Shuttle flight deck seat three and middeck seats five and seven. Each seat will have 3 triaxial accelerometers, placed on the seat pan, the backrest, and the headrest. No crew operations are required for the Crew Seat DTO. While Crew Seat DTO data alone are important in terms of providing a measure of vibration and g-loading, human performance data are required to fully interpret the operational impact of the vibration values collected. These human factors data will be provided by Visual Performance which has been designed for participation of the Shuttle middeck crewmembers in seats five, six, and seven over the course of three flights, for a total of nine potential subjects (three crewmembers per flight).

Crewmembers will be requested to view a placard attached with Velcro to the middeck lockers directly in front of them. The placard will depict a representative Orion display format in each of four quadrants (i.e. four numbered display formats per placard). Each display format will depict a different effective font size, for a total of four tested font sizes. Crewmembers will indicate the minimal font size readable during the launch phase of the flight using a response card included in their kneeboard or flight notebook. Once vibration has subsided (after solid rocket booster separation and prior to main engine cut off), the crewmembers will respond to a brief questionnaire. A postflight debrief will be held with crewmembers to elaborate on their experience. When practical within mission constraints, a video camera will record the motion of the middeck crew for correlation with seat vibration.

Project Type: Payload

Images and Captions:

Visual Performance placard configuration.



Schematic of Visual Performance SDBI and Crew Seat DTO.

Operations Location: Sortie

Brief Research Operations:

- Crewmembers will be requested to view a placard attached with Velcro to the middeck lockers directly in front of them. The placard will depict a representative display format in each of four quadrants (i.e. four numbered display formats per placard). Each display format will depict a different effective font size, for a total of four tested font sizes.

- Crewmembers will indicate the minimal font size readable during the launch phase of the flight using a response card included in their kneeboard or flight notebook. Once vibration has subsided (after solid rocket booster separation and prior to main engine cut off) the crewmembers will respond to a brief questionnaire.

- A postflight debrief will be held with participating crewmembers to elaborate on their experience. When practical within mission constraints, a video camera will record the motion of the middeck crew for correlation with seat vibration.

Operational Requirements: Nine crewmembers are targeted for this investigation (those assigned to middeck seats five, six, and seven on STS-119, STS-127, and STS-128). All lights in the middeck must remain on during ascent. When practical within mission constraints, a digital video camera/recorder system will record crewmember motion; the video will be time-stamped for later correlation with the Crew Seat DTO data.

Operational Protocols: Prior to flight, placards which depict planned Orion display formats in four font sizes will be mounted on the desired middeck locker locations. These placards will be no larger than a single locker face, approximately 11-inches x 17-inches.

The crew will be trained to scan the quadrants at pre-selected time points in the ascent profile, including pre-launch, liftoff, pre-max q, max q, post-max q, and post- solid rocket booster separation. Crewmembers will indicate the quadrant number of the smallest readable font on a response card included in their kneeboard or flight notebook.

When available, a video camera mounted in the middeck with a view of the crew will record visible crew vibration response during the ascent phase of flight; video information will be correlated with the accelerometer data taken as part of the Crew Seat DTO.

Once the shuttle achieves main engine cut-off, a short questionnaire attached to the crewmember's kneeboard will be used to collect supplemental subjective data.

After orbital insertion, the response card, questionnaire, and video tape will be stored in the Return-to-Houston bag for later return to Earth. The placards will be removed from the locker faces and stowed.

A detailed debrief will occur once crewmembers return to Johnson Space Center in Houston, TX. For any crewmember returning on a different flight (i.e. long-duration ISS crewmembers launched via Shuttle), the debrief will be conducted via e-mail.

Review Cycle Status: PI Reviewed

Category: Human Research and Countermeasure Development for Exploration

Sub-Category: Human Behavior and Performance

Space Applications: The Constellation Program (CxP) Thrust Oscillation Focus Team (TOFT) has requested assistance in development of CxP unimpeded crew performance specifications. Testing was done during the Gemini program to determine vibration amplitude and frequency acceptability for crew performance under increased g-loads. These studies were never systematically validated with flight data, and were performed using Gemini era displays and controls, in contrast to the glass cockpit concepts

currently planned for future exploration vehicles. The Visual Performance investigation will determine middeck crew visual performance and provide the CxP TOFT and the Human Systems Integration Group (HSIG) with data for inputs to further ground testing, and will provide validated flight data from which performance requirements can be developed.

Earth Applications: Data from Visual Performance will also provide insight into displays for workers who read displays under extreme vibration such as pilots or race car drivers.

Manifest Status: Continuing

Supporting Organization: Exploration Systems Mission Directorate (ESMD)

Previous Missions: Expedition 18 is the first mission for the Visual Performance investigation.

Web Sites:

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